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STORAGE

No. 5. PAPERS ON INDIAN TABANIDÆ

I. A PRACTICAL AND SIMPLE METHOD FOR REARING TABANID LARVÆ

II. THE NUMBER OF MOULTS IN TABANID LARVÆ

III. THE LIFE-HISTORY OF *TABANUS CRASSUS*, WALKER, AND THE IDENTITY OF THE FEMALE OF THE SPECIES

BY

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Second Entomologist (Dipterist), Pusa

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and

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PAPERS ON INDIAN TABANIDÆ.

BY

P. V. ISAAC, B.A., D.I.C., M.Sc., F.E.S.,

Second Entomologist (Dipterist), Pusa.

[Received for publication on 22nd February 1924]

I. A PRACTICAL AND SIMPLE METHOD FOR REARING TABANID LARVÆ.

Introduction.

Since 1760, when Degeer, the Swedish Naturalist, published a paper on the larval and pupal stages of *Tabanus bovinus*, L., the European horse-fly, this being the earliest account of any observation on the pre-imaginal phase in the life-history of Tabanids, many others have written on the development of Tabanidæ, but it is only in recent years that any one has produced an account touching on all the successive stages in the growth of these insects. The chief reason for this is that, apart from their general interest to the student of Entomology, although recognised as blood-sucking pests of cattle, keen interest was taken in them only after they were suspected of infecting stock with anthrax and surra. This happened in 1902, about which time, following an importation of Indian zebu cattle, there occurred an outbreak of surra in the United States of America.

Historical.

A perusal of literature on the life-history of Tabanids shows that all methods of rearing so far attempted have been unsatisfactory. Hine[1] (1906) was the first to use any kind of rearing apparatus and advocated, after some experimental work, jelly-glasses having the cover perforated with a few holes and containing moist sand to a depth of 3 inches, covered over the top with a

[1] Hine (1906). Habits and life-histories of some flies of the family Tabanidæ (*U. S. Dept. Agri. Bureau Entomology, Technical Series* 12, pt. 2.)

quantity of fine leaves of water plants, and supplying minute aquatic invertebrates, chiefly crustaceans, for food. King[1] (1908) used small glass basins containing mud, water and growing grass and fed the larvæ on freshly-killed mosquito larvæ and earthworms. Neave[2] (1915) reared the larvæ in small basin-shaped vessels of hard clay, varying from 6 inches to a foot in diameter, containing wet mud or sand, and for food he supplied larvæ of Muscid flies and freshly-killed small tadpoles, molluscs and fish fry. Mitzmain[3] (1913) improved on Hine's method. He kept the larvæ separately in glass jars, one-third filled with clean wet sand and provided with strips of filter paper soaked in muck from a creek bottom. Minute crustaceans, mosquito larvæ and young angleworms furnished the diet.

Patton and Cragg[4] (1913) preferred to Hine's method the use of large galvanised iron trays six feet long and six inches deep, and three quarters filled with water and with sand and mud sloped off to form a bank above the water level, and stocked with water plants, small crustaceans and earthworms. Marchand[5] (1917) found it satisfactory to use test-tubes about seven and three-quarter inches long with a roll of filter paper and about half an inch of water in them, providing earthworms and bits of meat for food.

Drawbacks of above methods.

Obviously, except in Marchand's method, it is impossible in these to secure reliable *data* on the growth and the occurrence of moults. The environment obtained in Marchand's tubes is bound to be very unlike that under natural conditions. Repeated attempts, made by the present writer to rear just-hatched larvæ in such tubes, proved a failure, as the larvæ died in a few days. In the tray recommended by Patton and Cragg for rearing Tabanids in large numbers, according to the authors one should start only with at most fifty larvæ and finally from this about one-fifth will reach maturity. Hine's principle of segregating these highly predaceous larvæ in individual jars is excellent, and in this paper it will be shown how his method has been improved upon to provide at once all the necessary natural conditions

[1] King (1908). Report on Economic Entomology. (*Third Report, Wellcome Research Laboratory, Khartoum.*)

[2] Neave (1915). The Tabanidæ of Southern Nyasaland, with notes on their life-histories. (*Bull. Entom. Res.*, Vol. V.)

[3] Mitzmain (1913). The biology of *Tabanus striatus*, Fabr. (*Phil. J. Sc. Section B*, Vol. VIII.)

[4] Patton and Cragg (1913). *Text-Book of Medical Entomology.*

[5] Marchand (1917). An improved method of rearing Tabanid larvæ. (*Journal of Economic Entomology Concord*, Vol. X.)

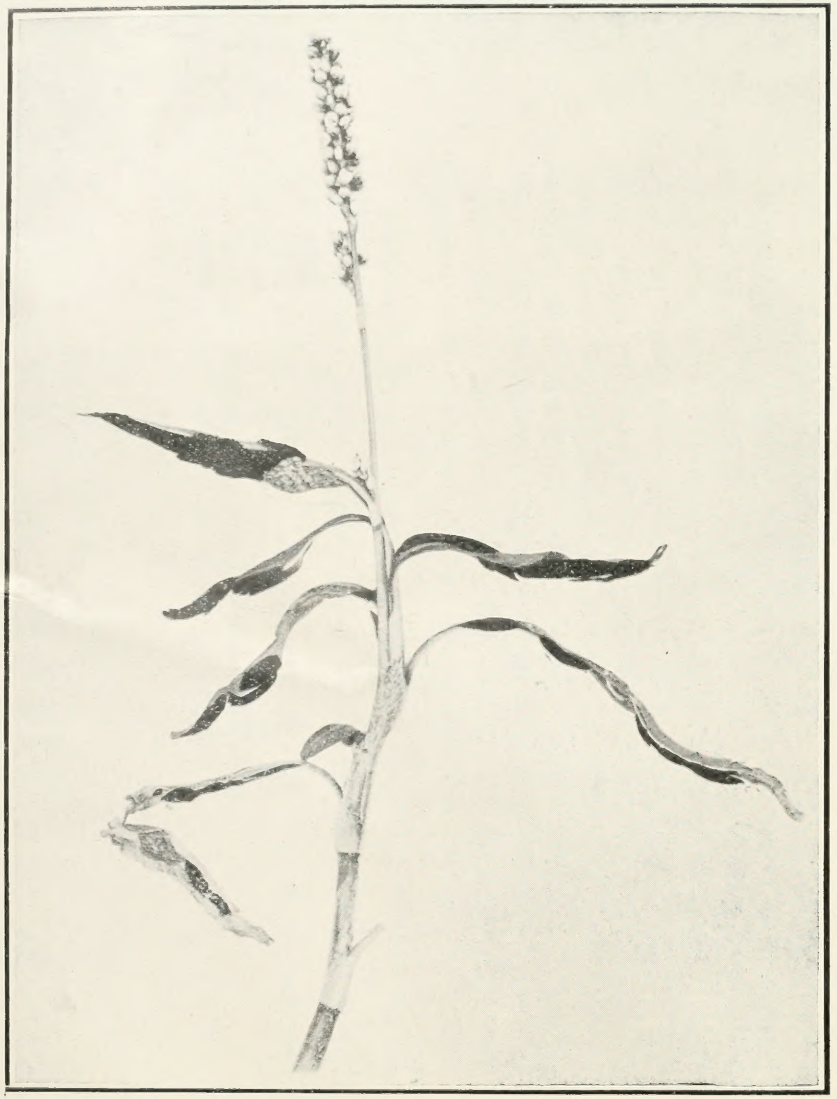


Fig. 1. A branch of *Polygonum glabrum* from the edge of a river, showing a large number of Tabanid egg-masses (Natural size).

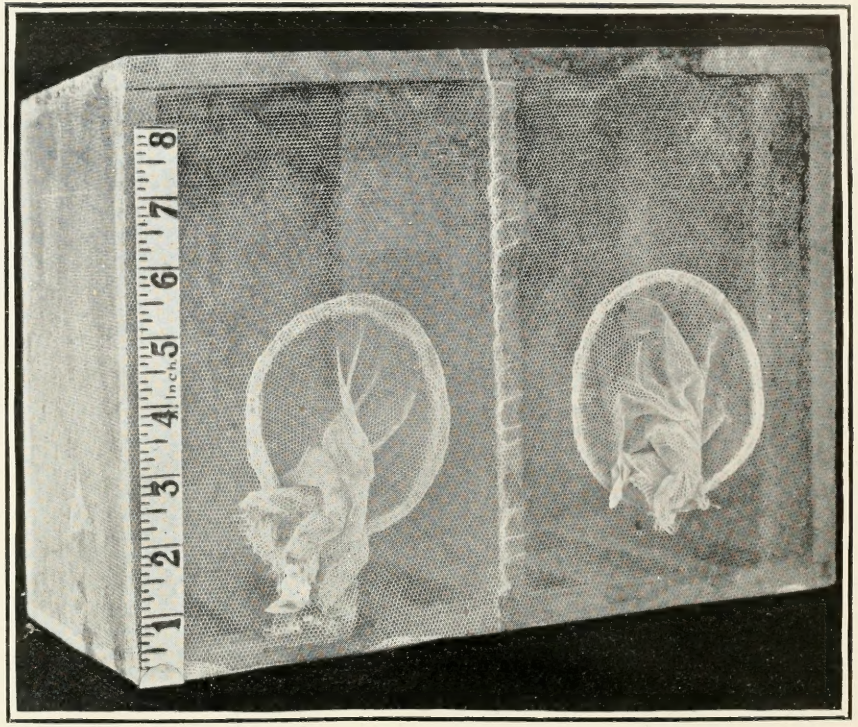


Fig. 2. Cage used for keeping adult female Tabanids.

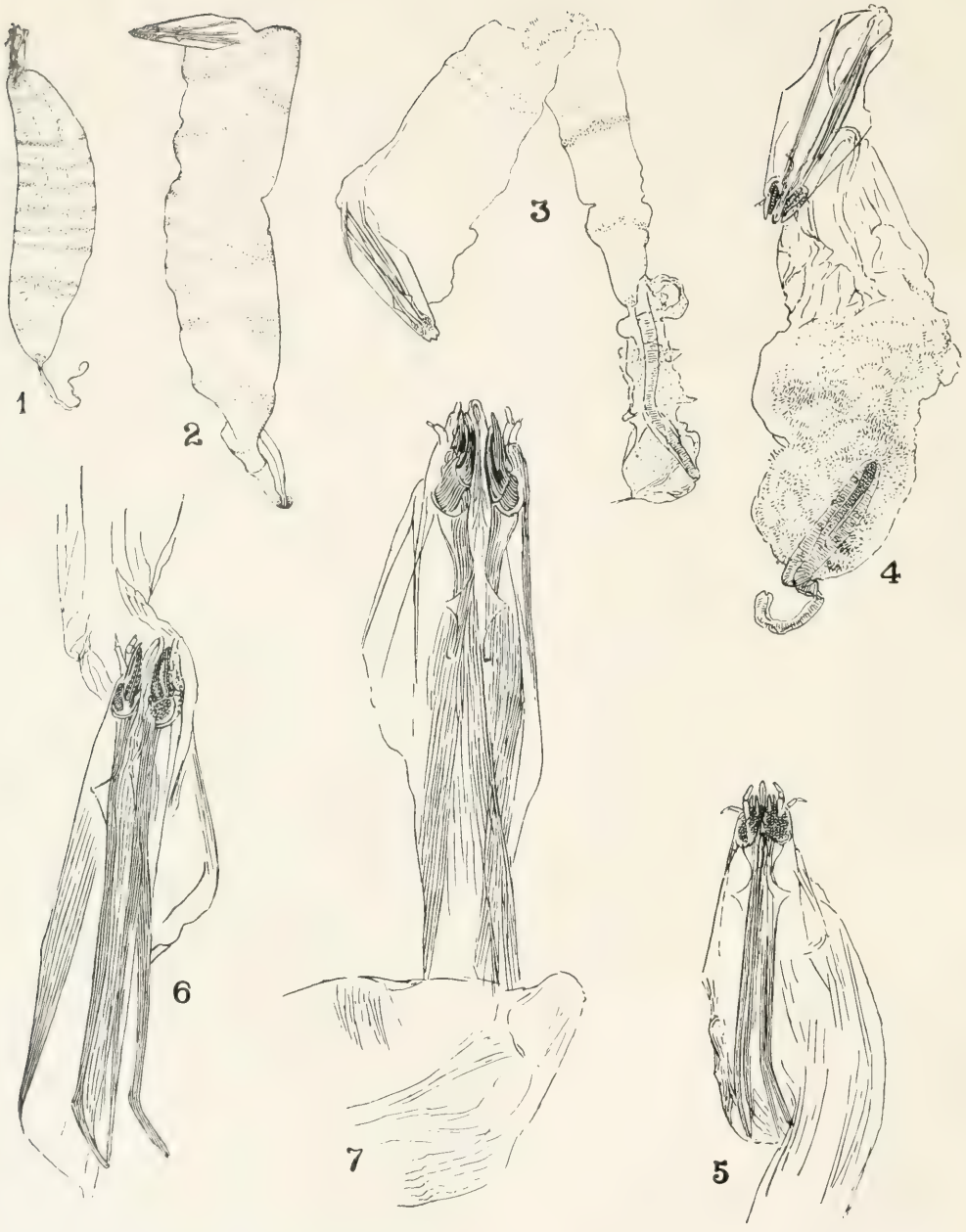
PLATE V.

and facilities for the close observation of the progress of growth of the larva.

Method recommended.

If it is desired to follow a life-history closely it may be possible to collect egg-masses from where they are laid in nature. Most Tabanids lay their eggs on plant stems or leaves overhanging water at the edges of streams, irrigation channels or pools. The flies may also be captured specially off an animal they frequent for blood and the full-fed ones may be let into a cage of dealwood framework and mosquito netting and of dimensions as shown in Plate V, fig. 2. There are two compartments each with a sleeved opening. This arrangement gives both rigidity to the cage and also room for keeping two species at one time. It is sometimes possible to get a caught female to feed occasionally on a cow, pony or rabbit and to keep it in this cage until it lays eggs. The cage should be kept in a shallow tray with about an inch of water and the whole placed on a verandah or other suitable place where there is plenty of light, air and sunshine. The egg-masses are generally laid on the wooden framework and occasionally on the netting ; in either case it is easy to cut them out with some of the foundation. By this method one can have the exact date, and sometimes the hour, when the eggs were laid.

The egg-mass after collection is hung, by means of a bent wire or other suitable device, over a little water kept in a small glass beaker of about 4 oz. capacity. The eggs hatch in a few days, generally at the time of sunrise, and the larvæ fall into the water. All Tabanid larvæ seem to do a moult directly they reach water after hatching. The second-instar larvæ must now be examined to decide what will be a suitable condition to transfer them into. Some have large lateral tracheæ and float on the water, others have narrow tracheæ and sink. The first kind require a certain amount of water, whereas for the second free water is fatal. Glass beakers, similar to the size used first, are taken and filled about one-eighth inch with clean river sand which has been washed several times until, when shaken up with water, it settles down quickly and leaves the water clear. Some clean water is poured into the beaker with the sand and shaken up with the beaker slightly tilted and then allowed to settle so that the sand forms a sloping bank. A little water is allowed to remain at the bottom or all water is poured off according to the needs of the case. About eight such beakers may be prepared and numbered and with a pipette a definite number of larvæ, say four, starting on the second-instar are transferred into each of the first five and the rest of the larvæ may be divided equally into the other three. All these beakers



The number of Moults in Tabanid Larvæ.

1. First moult (× 24).
2. Second moult (× 24).
3. Third moult (× 24).
4. Fourth moult (× 20).
5. Fifth moult, only head and part of cuticle (× 20).
6. Sixth moult, only head and part of cuticle (× 20).
7. Seventh moult only head and part of cuticle (× 20).

are not attacked. Feeding may now be stopped. The larva now tends to show a more yellowish tint internally. Now more dry sand is introduced to fill about half the jar and just enough water poured in to keep the sand slightly damp. The jars may be examined daily to note when the larvæ pupate. After pupation in the course of a few days the adult will emerge and be found within the empty space in the jar.

The above method, it may be said in conclusion, is not suitable for certain peculiar Tabanids that breed in strange situations, as *Gastroxides ater*, Saunders, whose larvæ and pupæ are found in the silt in tree holes.

II. THE NUMBER OF MOULTS IN TABANID LARVÆ.

From the observations of Mitzmain[1] (1913) on the life-history of *Tabanus striatus*, Fabr., it has been generally believed that Tabanid larvæ moult thrice, passing into the pupal stage after the third moult. Previous workers have left no record of moults except King[2] (1908) who noticed in the case of *T. biguttatus*, Wied., the shed larval skin adhering to the pupa—a statement of no value as far as the number of moults are concerned—and Paoli[3] (1907) who also mentions moults in connection with his study of Gräber's organ. Cross and Patel[4] (1921) have noted a first moult which takes place in the case of *Tabanus bicallosus*, Ric., within 10 to 15 minutes after hatching and in *T. rubidus*, Wied, (=*T. albimedius*, Wlk.,) within 20 to 30 minutes after hatching.

During the year 1923 several species of Tabanids were reared at Pusa and the improved method described in a previous paper of mine enabled one to follow the development of and moults in the larva closely and accurately. As a result it has been discovered that there are really seven moults, the larva turning into pupa at the seventh moult (Plate VII). This has been the case in *T. rubidus*, Wied. (= *albimedius*, Wlk), *T. striatus*, Fabr. (= *hilaris*, Wlk.) and *T. tenens*, Wlk.

[1] Mitzmain (1913). The biology of *Tabanus striatus*, Fabr. (*The Philippine Journal of Science : Section B, Tropical Medicine*, Vol. VIII.)

[2] King (1908). Report on Economic Zoology. (*Third Report of Wellcome Research Laboratory, Khartoum.*)

[3] Paoli (1907). Intorno all' "Organo del Gräber" nelle larve di Ditteri Tabanidi. (*Redia*, Vol. IV.)

[4] Cross and Patel (1921). Surra transmission experiments. (*Dept. of Agriculture Punjab Veterinary Bulletin* No. 5.)

The following is a record of the early stages of *T. rubidus*, Wied. :—

Date			
April 10 ..	Eggs laid.		
„ 14 ..	Eggs hatched at 9-40 A.M.		
„ 14 ..	First moult over at 9-55 A.M.		
	Larva No. 1	Larva No. 4	Larva No. 6
„ 18 ..	Second moult	..	..
„ 20 ..	..	Second moult	Second moult
„ 21 ..	Third moult	..	..
„ 23 ..	..	Third moult	Third moult
„ 24 ..	Fourth moult	..	..
„ 25 ..	..	Fourth moult	..
„ 26 ..	..	..	Fourth moult
„ 27 ..	Fifth moult	..	..
„ 29 ..	..	..	Fifth moult
„ 30 ..	..	Fifth moult	..
May 4 ..	Sixth moult	..	..
„ 5 ..	..	..	Sixth moult
„ 7 ..	..	Sixth moult	Just before 11 A.M.
June 2 ..	..	At 11 A.M. Seventh moult : pupated	Seventh moult : pupated
„ 9 ..	..	..	..
„ 10 ..	..	Male fly emerged	Female fly emerged
„ 18 ..	Seventh moult: pupated		
„ 25 ..	Male fly emerged		

Although in all rearings of the above three species seven moults have always been observed, the case of *T. crassus*, Wlk., is an exception. In this species alone eight larval moults have been counted. *T. crassus*, Wlk., is one of the largest Indian Tabanids, and shows remarkable variation in colour between the sexes and has also a much longer larval period than in any of the other species studied and this may be the reason for an extra moult in it.

TABANUS CRASSUS, WLK.

Explanation of Plate VIII

Tabanus crassus, Wlk.

1a.	Egg-mass on leaf	× 1
1b.	Single egg	× 10
2a.	Second-instar larva	× 16
2b.	Mature larva	× 2
3.	Pupa	× 2
4a.	Adult female	× 2
4b.	Front view of head of female, magnified.	
4c.	Side view of the same, magnified.	
5a.	Adult male	× 1
5b.	Side view of head of male, magnified.	
6.	Female egg-parasite	× 24
7.	Male egg-parasite	× 24

EXPLANATION OF PLATE VIII

Tachinus crassus, Wlk.

1a.	Egg-mass on leaf	× 1
1b.	Single egg	× 10
2a.	Second-instar larva	× 16
2b.	Mature larva	× 2
3.	Pupa	× 2
4a.	Adult female	× 2
4b.	Front view of head of female, magnified.	
4c.	Side view of the same, magnified.	
5a.	Adult male	× 1
5b.	Side view of head of male, magnified.	
6.	Female egg-parasite	× 24
7.	Male egg-parasite	× 24

It may be noticed here that in all larvæ of Tabanids mentioned above, the first-instar larvæ present a peculiarity which has not been hitherto observed. This larva is unable to feed and the moult skin exhibits a head adapted to break the chorion and allow the larva to hatch out, a strong anterior dorsal spine being the chief feature of this mechanism.

III. THE LIFE-HISTORY OF *TABANUS CRASSUS*, WLK., AND THE IDENTITY OF THE FEMALE OF THE SPECIES.

(Plate VIII.)

Introduction.

Tabanus crassus, Wlk., is one of the largest flies of the genus *Tabanus* found in India. Nothing is known of its habits although it is quite likely that the female sucks blood from vertebrate animals. The very peculiar appearance of the egg-masses and lack of exact evidence as to what species they belonged to were the immediate reasons for studying the life-history recorded here. In the Pusa collection there are a few flies of this species collected from Pusa and one from the Khasi Hills, Assam. Other localities from which it has been recorded are Karwan (probably for Karwar) North Kanara, India; Lushai Hills, Burma; Java, Hongkong, Malacca and Formosa.

Pre-imaginal Stages.

The egg. The egg-masses, though rare, are conspicuous objects and have been collected at Pusa from leaves of plants overhanging water along a river bank. The eggs are laid vertically and packed close together to form an elongate hexagonal mass about 10 mm. long and 5 mm. broad. A white chalky substance is plastered thickly over the top and very thinly on the sides.

Each egg is a black narrow elongate slightly curved body about 2·5 mm. long and about 0·3 mm. broad at its thickest part. There are about 500 eggs in each egg-mass.

The just hatched larva is about 2 mm. long, of a yellowish-white colour and almost torpedo-shaped, but slightly blunt at the head end. The head is withdrawn into the body which shows eleven segments and a terminal siphon. The head has certain hatching spines in this stage, but this larva moults

within a few minutes of hatching and the second-instar larva is provided with mouth-parts adapted for feeding.

The full-grown larva has the usual Tabanid appearance, is yellowish-white in colour, and when fully extended is 35 mm. long. The head is completely retractile within the body which is clearly divided into eleven segments and the eleventh bears a siphon tube. The junction of the segments is marked by a grey band. Just posterior to this band the fourth and tenth and all segments between them have on a slightly thickened ridge another grey band which appears to carry a double row of closely set minute spines that encircle the whole segment, being also present in bunches on all the parapodia, of which there is a transverse row of six on each of these segments, one on either side and four on the venter. The parapodia are small muscular retractile processes which act as locomotor organs. The spines on them are slightly better developed than elsewhere, but not so prominent as in certain other Tabanids. The eleventh segment, which carries the anal opening, tapers away from the body and has a terminal process, the siphon tube, which is at times completely withdrawn into the body and which carries at its extremity the two almost contiguous vertical spiracles.

The pupa is about 18 mm. long and in general features resembles that of other Tabanids.

Life-history.

The incubation period has not been obtained as the time of laying has never been observed. From notes on a large number of egg-masses collected and hatched it is presumed that this period is about 5 to 7 days. The just-hatched larva moults immediately on falling into water and the second-instar larva, which possesses narrow lateral tracheal trunks, sinks in the water and crawls into the moist earth at the water edge. In the laboratory the larvæ were reared in damp sand and were fed on freshly-killed fly maggots collected from cow-dung. The larval stage in summer occupies about 15 weeks. The pupa is found in damp sand and the pupal period during the same season is about 18 days. Below is the record of one lot of adults reared from an egg-mass collected in the month of June.

Date				
June	28 ..	Egg-mass collected from river bank.		
July	3 ..	Larvæ hatched and did first moult.		
		Larva No. C_1	Larva No. F_1	Larva No. IV
..	11 ..	Second moult	Second moult	Second moult
..	21 ..	Third moult	Third moult	Third moult
..	26 ..	..	Fourth moult	..
..	27 ..	Fourth moult	..	..
..	30 ..	..	Fifth moult	..
..	31 ..	Fifth moult	..	..
August	2 ..	..	..	Fifth moult
..	3 ..	..	Sixth moult	..
..	5 ..	Sixth moult	..	..
..	8 ..	..	..	Sixth moult
..	12 ..	..	Seventh moult	..
..	16 ..	Seventh moult	..	..
..	19 ..	..	..	Seventh moult
October	14 ..	Eighth moult : pupated	..	..
..	17 ..	..	..	Eighth moult : pupated
..	20 ..	..	Eighth moult : pupated	..
..	31 ..	Female fly emerged	..	..
November	5 ..		..	Female fly emerged
..	8 ..		Male fly emerged	

Number of instars.

The larvæ, it will be seen from the above Table, passed through eight instars, whereas the rule in Tabanids seems to be seven instars.

Broods.

There are three broods at Pusa, one from about March to June, the second from June to October, and a third from October to the following March, hibernation in the larval stage taking place in this brood.

Natural enemies.

A Scelionid parasitizes the eggs and sometimes every egg in an egg-mass is destroyed by this.

The female of *T. crassus*, Wlk.

There is no previous direct information as to the identity of the female of this species—rarely have the two sexes of any Tabanid been seen together. From the rearing work undertaken at Pusa authentic females of the species have been obtained and they agree with the description of what Walker[1] (1850) has named *T. sanguineus*, of which only females are known. In the case of *T. crassus*, Wlk., the species is described by Walker[1] (1850) from male specimens and Ricardo[2] (1911) states that *T. basalis*, Macq., may prove to be its female. It is now definitely proved that *T. crassus*, ♂, Wlk., and *T. sanguineus*, ♀, Wlk., are conspecific and as the first name has priority the name *T. sanguineus*, Wlk., becomes a synonym.

[1] Walker (1850). *Insecta Saundersiana*, Vol. I.
[2] Ricardo (1911). *Records of the Indian Museum*, Vol. IV, No. VI.

August 1924 ENTOMOLOGICAL SERIES VOL. VIII, No. 6

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

No. 6. TWO DROSOPHILIDÆ FROM COIMBATORE

BY

J. R. MALLOCH

AGRICULTURAL RESEARCH INSTITUTE, PUSA

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TWO DROSOPHILIDÆ FROM COIMBATORE.

BY

J. R. MALLOCH.

[Received for publication on 22nd February 1924.]

Amongst some Diptera sent me recently for identification I found the two which are described herein. Both are evidently of economic importance, one feeding on fruit and thus to some extent injurious, and the other feeding upon Aphides and consequently beneficial.

Genus *Gitonides*, Knab.

Generic characters. Cephalic chætotaxy : postverticals small ; ocellars long, divergent ; each orbit with three strong bristles below the vertical one, the upper one in line with posterior ocelli, the middle one a little closer to the lower one than to the upper and, like the latter, backwardly directed, the lower one forwardly directed and farther from base of antennæ than from the median bristle ; entire frons with numerous short microscopic black setulæ ; face slightly convex, not keeled ; vibrissæ well developed ; antennæ as in *Drosophila*, but the arista is bare ; eyes large, bare. Thoracic chætotaxy : one short humeral ; presutural intra-alar short ; dorsocentrals two pairs, the anterior pair short and close to the larger pair ; scutellars four, the disc bare, prescutellar acrostichals large ; mesopleura bare ; sternopleurals 1 : 1 ; other characters as in *Drosophila*. Wing venation as in *Amiota*, Lœw, the discal and second basal cells separated by a cross-vein ; first posterior cell not narrowed apically, costa indistinct beyond apex of third vein.

Genotype, the following species :—

Eudrosophila perspicax, Knab.

Male and female. Habitus and colouration similar to *Drosophila repleta*, Wollaston. Brownish testaceous, opaque, thorax with grayish pruinescence, frons and dorsum of thorax profusely mottled with dark brown dots, one at base of each hair and bristle, on the dorsum of thorax more or less

aggregated in the form of interrupted vittæ and irregular groups : disc of scutellum mottled with brown and a rather conspicuous dark brown spot at base of each bristle ; a narrow brown vitta along upper margin and another along middle of pleura. Abdomen dark brown, apices of tergites testaceous. Legs testaceous. Wings hyaline.

Dorsum of thorax rather closely covered with short black setulose hairs. Abdomen ovate. Legs without abnormal armature, mid and hind tibiæ rather stout. Inner cross-vein slightly beyond middle of discal cell ; first vein ending almost above middle of antepenultimate section of fourth vein ; last section of fourth vein a little less than twice as long as penultimate section ; distance from apex of first vein to apex of second nearly three times as great as preceding costal section.

Length, 3·5—4 mm.

Several specimens, " amongst plant lice (young ones of the Fulgorid, *Pundaluoya simplicia*) on *cholam* shoot." Coimbatore (*Y. Ramachandra Rao*). Also " on cotton mealy bug " (*Pseudococcus corymbatus*, Green), Coimbatore, 13th March, 1920 (*T. V. Ramakrishna Ayyar*).

Originally described from Hawaii and occurs also in the Philippines. Sturtevant in his paper on the North American Drosophilidæ sunk this genus as a synonym of *Gitona* but in that genus the discal and second basal cells are not separated by a cross-vein, a fact noted by him, while the reverse is here the case.

Pinned with the male there is a puparium, but not the one from which the specimen emerged, as the puparium contains the undisclosed imago. This puparium is subopaque reddish brown in colour, 6 mm. in length and almost 2 mm. in width, with the ventral surface slightly flattened, the sides bulging a little, and the upper surface convex. The dorsal surface has the anterior fourth obliquely sloped to anterior margin as in most Drosophilidæ and the posterior extremity is not much attenuated, differing in this respect from the forms which live in liquids and semi-liquid matter. Anterior spiracular organs short, with about 13 short pale branches arranged fanwise at apices ; posterior spiracular trunks contiguous at bases, consisting of two upwardly diverging stalks which taper apically, are furnished with three small spiracular slits at tips, and are about twice as long as their basal diameter. Body covered with microscopic points, the segments moderately well defined.

Drosophila biarmipes, sp. n.

Male and female. Testaceous yellow, thorax and abdomen more or less shining. Head and thorax unicolourous. Abdomen with a dark border to

each tergite, in male with the apical two tergites largely or entirely dark brown. Legs yellow. Wings hyaline, in the male with a faint darker tinge at apices of second vein. Halteres yellow.

The male has the orbital bristles and ocellar bristles very small, the anterior proclinate orbitals being particularly minute, while in the female only the anterior reclinate bristle is minute, the others being well developed ; arista with 5 rays above and two below ; facial carina large, rather broad and flat on most of its length ; cheek linear ; one or two strong setulæ below vibrissa ; eyes hairy. Thorax with 8 series of intradorsocentral setulæ ; prescutellar acrostichals indistinguishable ; sternopleurals 1 : 1. Hypopygium of male more prominent than usual in the genus. Fore tarsus of male with two combs of short black bristles on basal segment on its inner surface, one at middle and the other at apex ; fore tarsus of female normal. Section of costa in front of apex of second vein in male a little over twice as long as the one behind it, in female fully 2·5 times as long ; penultimate section of fourth vein in male a little over twice as long as ultimate, in female over 2·5 as long as ultimate ; outer cross-vein at about 1·5 its own length from apex of fifth vein in male, about twice its own length in female.

Length, 2-2·5 mm.

Type, male, and allotype, Coimbatore, 30th August 1920. Paratype male and female, same locality, 24th August 1920. Reared from *Nim* (*Melia azadirachta*) fruit (Ballard).

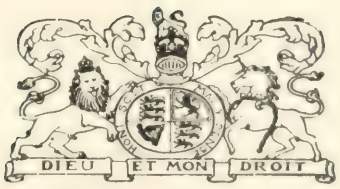
August 1924 ENTOMOLOGICAL SERIES VOL. VIII, No. 7

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

No. 7. A NEW APHIDIPHAGOUS FLY FROM COIMBATORE

BY

J. R. MALLOCH



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A NEW APHIDIPHAGOUS FLY FROM COIMBATORE.

BY

J. R. MALLOCH.

[Received for publication on 22nd February 1924.]

In 1921 I published a revision of the North American species of the genus *Leucopis*,* in which I erected two new subgenera for the reception of new species which differed in chætotaxy from those previously known.

Each of these subgenera contains but one species, that relegated to *Leucopomyia* feeding in the larval stages on the cottony maple scale (*Pulvinaria vitis*, Linné), and the one placed in *Neoleucopis* probably an enemy of Aphids on pine.

In the material sent to me from Coimbatore I find two species which are referable to the genus Leucopis *sens. lat.*, one being a true *Leucopis*, while the other belongs to *Neoleucopis*. The latter is new and is described herein; the former is probably new also, but the specimens are not sufficiently well preserved to warrant my describing the species at this time.

Leucopis (*Neoleucopis*) *luteicornis*, sp. n.

Male and female. Fuscous, densely covered with whitish gray pruinescence which entirely obscures the ground colour. Interfrontalia when seen from in front dark gray, much darker than the pale orbits and lunule; antennæ and palpi luteous, arista brown apically. Thorax with dorsum marked with two complete brown vittæ in line with the dorsocentral bristles, the margins of which are not sharply defined, and two pale gray slender vittæ between these on anterior margin which do not extend beyond suture. Abdomen with dorsum of first visible tergite blackish except in middle, second tergite

* "The subfamily Ochthiphilinæ"; *Bull. Ill. Nat. Hist. Surv.*, Vol. XIII, Art. 14 pp. 348-357.

with a round black spot on each side of median line, and a very faint dark central on the other tergites. Legs luteous, coxæ and femora more or less suffused with grayish fuscous. Wings whitish hyaline, veins yellowish. Calyptræ white. Halteres yellow.

Head compressed antero-posteriorly, when seen from the side its greatest length exclusive of antennæ is not half as great as its height, frons at vertex less than one-third of the head width, widened anteriorly at base of antennæ almost half as wide as head ; orbits narrow ; ocellar reclinate bristles weak, situated well in front of anterior ocellus ; frontal lunule almost transverse on upper margin, distance from base of antennæ to its upper margin equal to over half its width ; antennæ rather large, third segment disc-like ; arista short, subnude ; cheek as high as width of third antennal segment and about one-fourth as high as eye. Humeral and presutural intra-alar bristles weak ; posterior dorsocentral pair and prescutellar pair of acrostichals long, anterior pair of dorsocentrals very short, close to posterior pair ; sternopleura with one short bristle and some weak setulæ ; scutellar bristles rather short. First posterior cell of wing slightly narrowed apically ; last section of fourth vein about 2·5 as long as preceding section ; inner cross-vein a little beyond middle of discal cell ; outer cross-vein at twice its own length from inner and about 1·5 its own length from apex of fifth vein.

Length, 2-2·5 mm.

Type, male, allotype, and 4 paratypes, Coimbatore, 19th April. " Parasitic on Rain-tree mealy bug " (*Phenacoccus iceryoides*, Green) ; Ramakrishna coll.

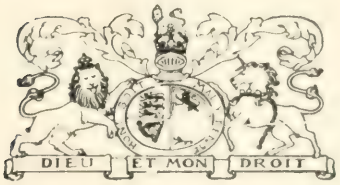
August 1924 ENTOMOLOGICAL SERIES Vol. VIII, No. 8

MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

No. 8. NOTES ON INDIAN ODONATA IN THE PUSA COLLECTION

BY

MAJOR F. C. FRASER, I.M.S



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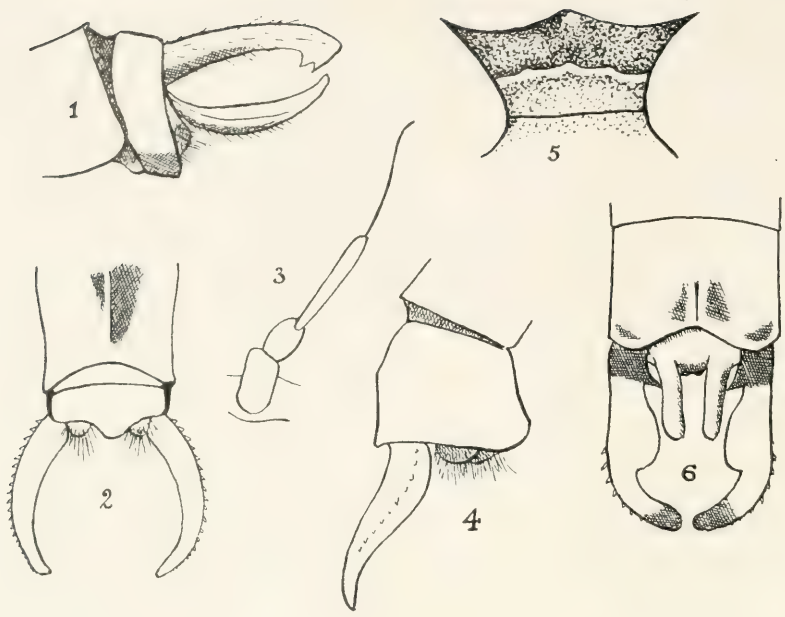
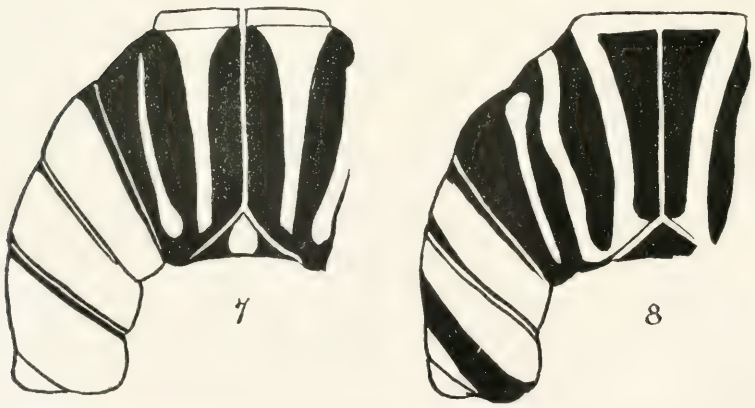




1. Anal appendages of *Tetrathemis aurea*. Male. Side view.
2. Anal appendages of *Philoganga montana* seen from above. Male.
3. Antenna of same.
4. Anal appendages of same seen from the side.
5. Occiput of *Macrogomphus montanus*, Selys, seen from above and a little behind.
6. Anal appendages of *Lestes nigriceps*. Male. Dorsal view.
7. Diagram of markings of thorax of *Macrogomphus montanus*.
8. Diagram of markings of thorax of *Orogomphus preciosus*.

NOTES ON INDIAN ODONATA IN THE PUSA COLLECTION.

BY

MAJOR F. C. FRASER, I.M.S.

[Received for publication on 22nd February 1924.]

SUBFAMILY LIBELLULINÆ.

Tetrathemis aurea, sp. nov.

Male. Abdomen 14 mm. Hindwing 16·5 mm.

Head. Labium yellow bordered with blackish brown, labrum and face black traversed by a broad yellow stripe on postclypeus, frons above and in front and vesicle metallic blue. Occiput black. Prothorax brownish.

Thorax brownish black on dorsum, bright yellow laterally traversed by an anterior and posterior blackish brown stripe.

Legs black, basal halves of anterior pair of femora yellow.

Wings hyaline, suffused with saffron as far as 2 cells proximal of trigone in forewing, as far as pterostigma in the hind, bases more deeply tinted, half way to arc in forewing, as far as arc in the hind. The outer paler area most intense between node and stigma, least intense along posterior border of wing and between node and arc. Pterostigma dark brown, sectors of arc fused for a great length, only 3 cells in loop, 2 cubital nervures in forewing, 3 in the hind, hypertrigones traversed once in all wings, 7 antenodals forewing, 6 in hind, 5 postnodals in all wings.

Abdomen blackish brown, the sides of 2 to 4 yellow, the first mentioned broadly so, less on 3 and still less on 4. On segment 2 the yellow extends upwards over segment forming a basal ring.

Anal appendages (Plate IX, fig. 1) yellowish brown, apices broadened turned down and in the extreme end furnished with two minute spines. Inferior appendage triangular, as long as the superiors.

Genitalia very small, lamina depressed, hamules minute, tumid at base briefly pointed at apex (but somewhat distorted as specimen rather teneral).

Female. Abdomen 17·5 mm. Hindwing 16·5 mm.

Very similar to male, differs as follows:—Saffronation of wings paler, less extensive, only 2 cells beyond in forewing, not quite as far as stigma in hind, area of greatest intensity at node. Four cells in loop.

Posterior lobe of prothorax bordered with bright yellow.

Dorsum of thorax glazed blue metallic, the anterior lateral stripe of blackish brown fuses with dark colour of dorsum and encloses a humeral stripe of yellow. Abdomen similar but segment yellow at the sides.

Vulvar scale of great length, tongue-shaped, extending to end of abdomen.

A single pair from Mergui, Lower Burma, collected by Mr. J. Elton Bott, male, 28th September 1922, female, 2nd September 1922. Both specimens are somewhat teneral and rather flattened by compression in paper packets. Both specimens in the Pusa collection.

The species is very similar to *T. flavescens*, Kirby, and is probably only a subspecies. It differs by having 3 cubital nervures in hindwing instead of 4 and by having only 2 spines beneath apex of superior appendages instead of 4 or 5. The face of *flavescens* is entirely yellow instead of only a transverse stripe.

Sympetrum haematoneura, sp. nov.

Male. Abdomen 26 mm. Hindwing 31 mm.

Head. Labium ochreous, mid lobe black, labrum, face and frons blood red, as also the eyes. Vesicle and occiput dark yellowish brown.

Prothorax brown.

Thorax blood red with a narrow black humeral stripe and a broad similar coloured stripe lying in front and parallel with the postero-lateral suture. Venter largely black. Legs entirely black.

Abdomen blood red above, unmarked, black beneath marked with red, the apical and midventral borders of all segments broadly and the whole of underside of 10.

Anal appendages red, tipped obscurely with dark brown, four or five minute black spines on underside of apex of superiors.

Wings hyaline, reticulation red as far as node, black beyond; pterostigma black, deep reddish brown by transmitted light; nodal index:— $\frac{9\text{-}8\frac{1}{2} \mid 8\frac{1}{2}\text{-}9}{9\text{-}6 \mid 7\text{-}10}$, a single row of cells between *Rs* and *Rspl.*

Genitalia. Hamules of about equal length, the inner curling slightly, the outer running parallel with the lobe which is rather long narrow and rounded at apex.

Hab. A single male from Nilnag, Kashmir, 6,900 ft., collected by T. Bainbrigge Fletcher, 15th August 1923. Resembles *hypomelas* rather closely and

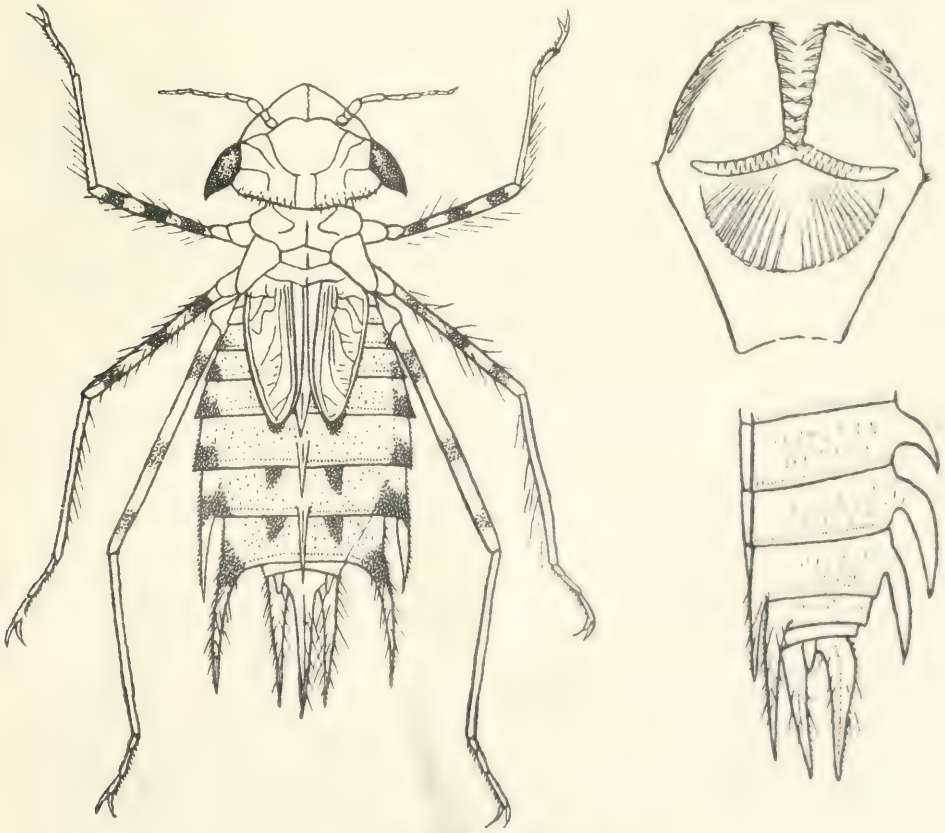
is probably closely related to it. Differs by the reticulation of base of wing, red instead of black, and by the red markings beneath abdomen (entirely black in *hypomelas*). In the latter species also the hamules are of unequal length, the outer being much longer than inner. In *hypomelas* again I find the antenodal nervures of forewing numbering $9\frac{1}{2}$, often $10\frac{1}{2}$ and occasionally $11\frac{1}{2}$, whereas there are only $8\frac{1}{2}$ in the present specimen.

Larva of *Hydrobasileus croceus*, Brauer.

Total length 25 mm. Greatest breadth (abdomen), 10 mm.

Head triangular, the outer angles formed by the eyes which are produced outwards and backwards cone-like and acutely pointed, black. Antennæ long filiform. Occiput broad rounded coated sparsely with short stiff black hairs.

Synthorax comparatively small, wing cases apposed, extending to 6th segment.



Larva of *Hydrobasileus croceus*, Br.

Abdomen flattened beneath, broadly arched above, 6th to 8th segments with very robust backwardly directed spines on the mid-dorsal carina, that on 8 more inclined than the one on 7 and that on latter more inclined than the one on 6, each overlapping the succeeding spine. Laterally strongly convex, segments 8 and 9 ending in very long formidable spines directed straight back and overlapping. Paired pigmented spots on tergites of 7 to 9 and lateral spots on segments 3 to 9. Appendix dorsalis and cerci of great length, spine-like parallel and of about equal length.

Legs long and spidery, anterior pairs coated with coarse hairs, the middle rather more sparsely so, femora with distal medial and proximal bands of pigment.

Mask cupped, mentum rounded and furnished with 11 long setæ converging at their apices, lateral lobes broadly triangular, outer border furnished with 9 or 10 setæ and a moderately long movable spine at apex, apposed borders with a row of 9 sets of spines in twos or threes. Inner borders with smaller single teeth fitting between a row of five smaller spines on middle lobe.

The specimen from which the figure was drawn is almost transparent, pale green in colour and was found lurking amongst water weed. In consequence of its translucency the tracheation of wing cases is depicted with great clarity and the following points are observed :—

The subcostal nervure throws off pairs of tracheolets corresponding to the antenodal nervures of first and second series. Similarly the radius after the node throws off pairs.

The arc is formed by a direct fusion of *M* with *Cu*, the apex of the loop of former coming into contact with the latter without interposition of any cross-nervure. (This is actually to be expected in so highly specialized an insect as *H. croceus*.)

Rs passes between the fork *Mi*, *Mii*, viz., over *Mi* and beneath *Mii*.

Rs throws off three pairs of tracheæ which run parallel to border of wing, *Miv* throws off three unpaired similar branches, the outer one of which soon forks.

Mia forks soon after its origin.

Cuii has a bayonet-like bend corresponding to outer border of loop and then bends abruptly backward to form outer border of apex of loop. At this bend a small branch leaves the main robust stem and runs in continuation of the line of the trachea and after the bend a second branch is sent off to the border of wing.

Cui is merely a fine branch of *Cuii* in this specimen, it is half the calibre of the main stem forming the outer border of loop.

The anal trachea throws off a number of parallel branches which run towards the wing border, all bifurcating at a common level, many of the so-formed branches anastomosing.

Lastly, the minute tracheolets forming the areolets of wing are nearly all plainly discernible. Contrary to this the outer and costal borders of trigones, although plainly made out, show no sign of previous tracheation, merely cuticular thickening. It would thus appear that the whole of the wing reticulation of the wing is laid down on tracheæ or tracheolets, the few exceptions being laid down on cuticular thickenings caused probably by stress and strain throwing the membrane into longitudinal folds. (Easily demonstrated by stretching a handkerchief in any one direction.)

Tramea basilaris burmeisteri, Burm.

A female from Mergui, Lower Burma, collected by Mr. J. Elton Bott, differs from type by the basal marking in hindwing very restricted, occupying only the extreme base of the cubital space and a few cells in the anal triangle, 2 cells wide at the cubital space, extending about one-third the distance from this space to the tornal angle of wing.

Pusa collection.

Subfamily Cordulianæ.

Azuma vittigera, Ramb.

A fine female of this insect from Mergui, Lower Burma, collected by Mr. J. Elton Bott, 1922, now in the Pusa collection.

Abdomen 58 mm. Hindwing 53 mm.

The dark basal rays, deep brown in colour, extend to the 5th antenodal nervure in forewing, to 6th in hind in the subcostal space, in eubital space of forewing as far as arc, and in both cubital and median spaces in hindwing for the same distance.

There is also a faint brown suffusion at the nodes. Nodal index,— $\frac{9\text{-}19 \mid 19\text{-}10}{12\text{-}15 \mid 13\text{-}11}$. The vulvar scale is small, deeply cleft into two triangular processes which overlap the 9th segment.

Thorax brown with a yellow humeral stripe and a lateral which is bordered on either side by darker brown. Abdomen does not differ from *cyaniocephala* in markings.

Macromia cupricincta, sp. nov.

A single male from Mokpalin, Thaton District, Burma, taken about 11-30 A.M., hawking low over a shady jungle path. Coll., J. Elton Bott, 10th May 1923.

Male. Abdomen 43 mm. Hindwing 38 mm.

Head. Lips, face and frons all uniform brownish yellow ; eyes probably emerald green during life ; occiput dark brown.

Thorax reddish brown, upper part of dorsum obscurely metallic green, humeral stripe absent, a rather broad mediolateral stripe of yellow on each side bordered narrowly in front and behind by blackish brown.

Legs blackish brown, proximal ends of femora reddish brown.

Wings hyaline, very palely enfumed, a very short dark brown ray in the subcostal space of all wings, extending outward not nearly as far as the first antenodal nervure ; membrane white ; stigma blackish brown, unbraced, over 1 to 2 cells, outer end much more oblique than inner ; nodal index $\frac{6\text{-}15 \mid 14\text{-}5}{7\text{-}12 \mid 11\text{-}8}$; hypertrigones traversed four times in forewings, twice in the hind ; 5 cubital nervures in forewing, 2 to 3 in the hind, 6 cells in loop. Tornus very acute and prolonged.

Abdomen. Segment 1 reddish brown, 2 with the basal half yellow, apical half dark reddish brown, 3 with rather more than the basal half yellow, the apical part black, the basal part of dorsum diffusely brown, this graduating into the yellow, 4 to 6 with basal half yellow, apical half black, 7 with rather more than the basal third bright yellow, the remainder reddish brown, segments 8 to 10 and anal appendages dark ochreous, 10 strongly keeled, the basal part of keel prolonged into a rather long thin and very finely pointed dorsal spine.

Anal appendages. Superior long and tapering, as long as the two last segments taken together, curling gently inward and downward, furnished at the middle of outer side with a robust blackish spine, apex finely pointed and turning slightly up. Inferior slightly longer than superiors, narrowly triangular, curling up at apex.

Genitalia. Lamina very depressed, deeply and narrowly cleft, hamules broad at base, rapidly narrowing to a long, fine hook curled somewhat like a button-hook, lobe long narrow tongue-like, overlapped by the hamules.

This new species belongs to Group *cincta* ; it has the delicate and small build of *M. cincta* but differs from that species by its general reddish brown colouring and by having the abdomen ringed instead of spotted. On the other hand, it resembles it by the needle-like spine on segment 10 and by the shape of its genitalia, so that it may be merely a local race of *cincta*.

SUBFAMILY CHLOROGOMPHINÆ.

Orogomphus preciosus, sp. nov.

Female. Abdomen 57 mm. Hindwing 47 mm.

Head broad from side to side, eyes separated by about 1·5 mm., frons as high as occiput. Labium pale brownish yellow, labrum ochreous, anteclypeus dark brown, postclypeus bright citron yellow, frons brown in front, black above, the crest finely yellow, vertex black, occiput yellow fringed with long brownish black hairs.

Prothorax brown.

Thorax black marked with bright yellow as follows:—a complete mesothoracic collar, an antehumeral and humeral stripe both extending full length of dorsum and narrowly confluent above thus enclosing an oblong spot of the ground colour. The antehumeral stripe expanded above and connected below with the mesothoracic collar. A very narrow posthumeral stripe lying close to and parallel with the humeral stripe, two very broad stripes on the sides narrowly separated by a fine black line, broadly separated from the posthumeral. Finally the extreme ventro-posterior border of metepimeron. Beneath yellow striped obliquely with black. (Plate IX, fig. 8.)

Legs black, anterior femora striped with yellow posteriorly.

Wings hyaline, saffronated at bases, in forewing as far as outer end of trigone at the costa, as far as its posterior angle at the border of wing, in hindwing rather less extensive, only as far as trigone and for a few cells in anal triangle. Greatest breadth of wing at distal end of *Cuii* 15·5 mm. Trigone of hindwing with costal and proximal sides equal, outer side slightly longer, in forewing costal side slightly longer than outer and both half as long again as proximal. Loop with 11 cells, nodal index:— $\frac{13\text{-}20\ 22\text{-}13}{16\text{-}20\ 20\text{-}17}$, 7 cubital nervures in all wings, 4 nervures in hypertrigones of forewings, 3 in the hind, *only* 1 *median nervure in all wings*, a basal antenodal nervure of second series in all wings, pterostigma over $2\frac{1}{2}$ cells, black narrow 3·2 mm. non-braced. Membrane dark brown. Trigones of forewings traversed twice by vertical nervures, in hindwing by three nervures which meet at centre of trigone.

Abdomen tumid at base, of about even width and cylindrical from 3 to base of 7 where it is somewhat dilated, 8 as broad as 7, 9 and 10 narrowing and decreasing in length progressively. Black marked with yellow as follows:—Segments 1 to 3 rather broadly on the sides, 2 with a pair of large transverse spots on dorsum at middle of segment and an obscure pair at apical border, 3 with similar but smaller spots, 4 to 7 with only the apical pair of

spots which decrease in size from 4 to 6 but larger and confluent over dorsum on segment 7. Ventral borders of 8 and 9 narrowly yellow.

Anal appendages very short, black, separated by a large conical process as long as themselves.

Vulvar scale very short, rudimentary, a mere convexity of the apical border of segment 8.

Hab. A single female from Sikkim, 4,000 ft., Mangpu, 10th May 1922.

I think it is fairly obvious that the male described by Laidlaw (*Rec. Ind. Mus.*, Vol. XI, p. 198; 1915), as the male of *speciosus* is really the male of this species as the two come from the same district, whereas *speciosus* comes from Burma. The venation of the two agrees rather more closely than does that of the male with *speciosus* and it is very significant that, whereas there are 2 median nervures in the latter, there is only 1 in all wings of the new species and Laidlaw's male.

Distinguished from *speciosus*, to which it is closely related, by the bright basal saffronation of wings, by having only 1 median nervure to all wings, by having 3 cells in trigone of forewings, labrum yellow instead of black marked with yellow and by the two posterior stripes on sides of thorax of even width (the middle stripe the broadest in *speciosus*).

Distinguished from *splendidus* by the basal saffronation of wings far less extensive, by the apices of wings uncoloured, by the postnodal nervures more numerous (17 instead of 14) and by the labrum all yellow instead of all black. From *atkinsoni* the difference in shape of head and abdomen and saffronation at bases of wings will serve to differentiate it.

Type in the Pusa collection.

Subfamily Gomphinæ.

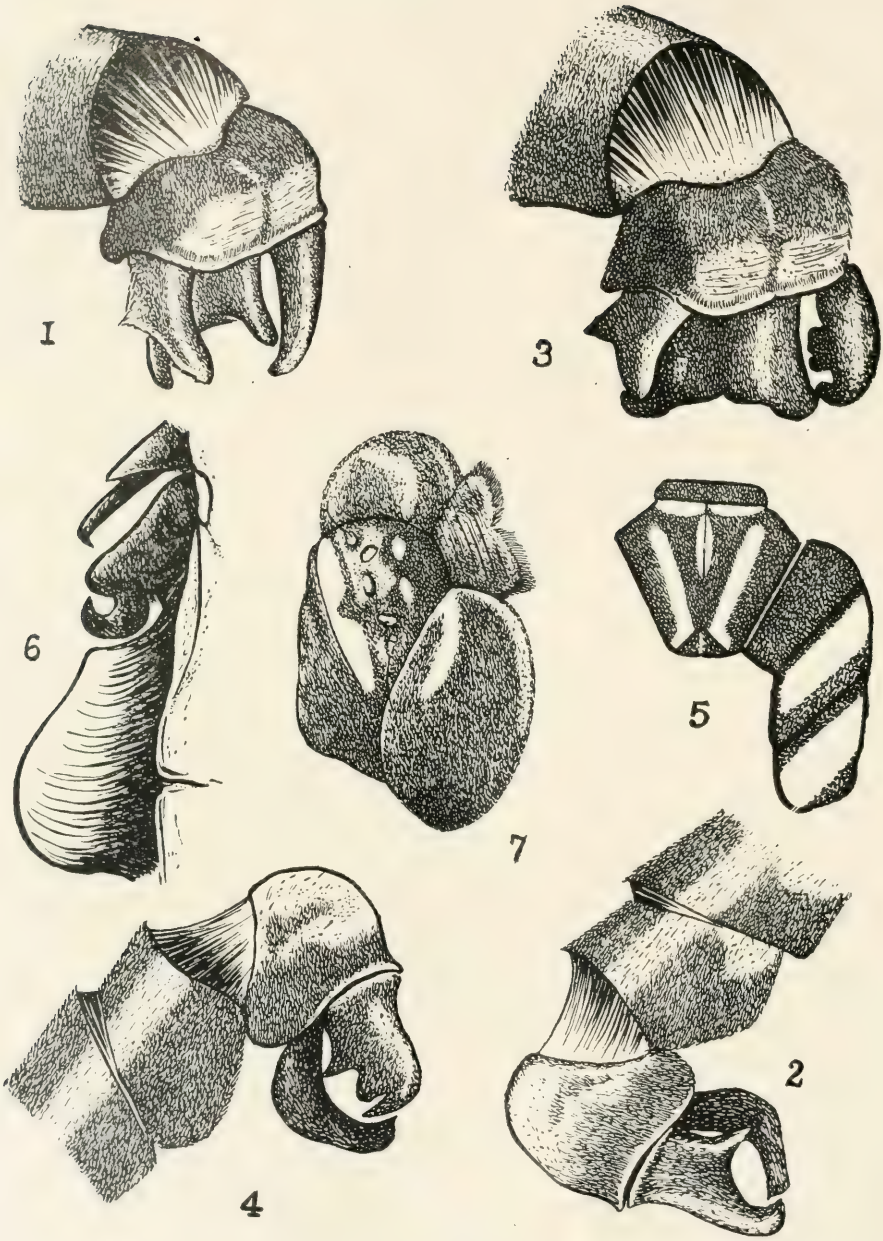
A new species of *Hagenius* (*H. nigricolor*) from the South Shan States.

Only two species of the genus *Hagenius* have been described, *H. gigas*, Mart., from Tonkin, and *H. brevistylus*, Selys, from North America, which, together with the third species to be described, all agree in their general facies, rather small head, long narrow wings, heavily built body and curiously shaped short robust anal appendages. The genitalia of *gigas* have not been described but those of *brevistylus* and the new species agree so closely that I have been unable to find any points of divergence.

Hagenius nigricolor, sp. nov.

Male. (Female unknown.) Abdomen 54 mm. Hindwing 49 mm.

Head. Eyes dark olivaceous brown, lips, bases of mandibles, clypeus, the frons in front, vertex and occiput glossy black, upper surface of frons



1. Latero-dorsal view of anal appendages of *Hagenius nigricolor* sp. nov.
2. Side view of same.
3. Latero-dorsal view of anal appendages of *Hagenius brevistylus*, Selys.
4. Side view of same.
5. Thoracic markings of *Hagenius nigricolor*.
6. Genitalia of same viewed in profile.
7. Head of same, latero-dorsal view showing the curious shape of occipital plate.

bright greenish yellow, its base narrowly black, this colour extending for a short distance forwards in the floor of the sulcus.

Occiput of remarkable shape (Plate X, fig. 7), projecting squarely back as a thick plate which overhangs the prothorax, its posterior border slightly notched in the middle and densely fringed with short stiff black hairs, its upper surface coarsely corrugated transversely and slightly hollowed out. Vertex raised into two prominent points closely simulating the condition found in Libellulines.

Prothorax velvety black marked with two small yellow points on the mid-dorsum.

Thorax black marked with yellow as follows :—A complete mesothoracic collar confluent with a lower stripe on the lower half of the mid-dorsal carina, narrow antehumeral stripes slightly divergent in front but not confluent with the mesothoracic collar, the upper ends turned out slightly at an obtuse angle. No vestiges of a humeral stripe. Laterally a rather narrow stripe well in front of the spiracle and a second covering rather more than the posterior half of the metepimeron. Tergum and attachments of wings spotted with yellow. (Plate X, fig. 5.)

Legs black, of great length, hind femora extending back nearly as far as the apical end of segment 2, furnished with a row of closely set, widening and lengthening spines towards the distal end, tibial spines of same legs very closely set, relatively short but very thick and robust, the mid-femora with spines more closely set and a few longer ones at the distal end. Hooks of tarsal claws very minute, situated near the middle of claws.

Wings long and narrow, resembling those of *Petalura* superficially, hyaline ; pterostigma elongate, dark brown between black nervures, braced, over 6 to 7 cells, 6 mm. long ; membrane nearly obsolete, hyaline ; costa finely yellow ; 3 rows of cells between *Mi* and *Mia* ; 2 cubital nervures in all wings, all trigones traversed once, the trigone of hind wing longer and narrower than that of fore, its outer side markedly angled where the accessory nerve takes off ; 2 rows of postanal cells in forewing, 5 in the hind, where there is a distinct loop of 3 cells ; anal triangle of 3 cells ; a basal antenodal nervure of the 2nd series in all wings ; nodal index $\frac{13\ 18}{14\ 14}\Big|\frac{20\ 12}{13\ 15}$.

Abdomen black marked with yellow as follows :—The sides of segment 1 and 2 broadly, this colour running up on the dorsum along apical margin of segment 2, a fine obscure mid-dorsal line on segment 2, 3 with the basal portion of sides yellow, 4 to 7 with basal lunules separated above by the dorsal

crest, 8 with about the basal half yellow, rather more than half on the sides, 9 with a small baso-lateral spot, 10 wholly black.

Segments 1 and 2 very tumid, 4 to 6 slim and cylindrical, 7 gradually dilating apicalwards, 8 and 9 dilated to about double the width of 7, with short foliate lateral processes, 10 short and square, its dorsum rounded.

Anal appendages (Plate X, figs. 1 and 2) black, very short, barely longer than segment 10, the inferior only slightly shorter than the superiors. Superior broad for rather less than the basal half, then abruptly tapering to a point and converging gently inwards towards one another, the apices not however meeting. At the point where they begin to taper, a robust ventral spine directed downwards. Inferior curling upward, squared, a robust digitate process springing from each outer corner and curling upward and, at the apices, a little outward.

Genitalia (Plate X, fig. 6). Lamina depressed, acutely notched in the middle, as if cut with a knife ; inner hamules two thin stillettes running back and downward, converging on one another, their extreme apices curled a little outward. Outer hamules very broad, long and robust, the ends squared, a robust hook, shaped like a tiger's claw, springing from the outer corner ; vesicle enormously inflated, rounded, shiny.

Distribution. A single male from the Southern Shan States, collected by Captain Drummond and kindly sent to me by Mr. C. M. Inglis. Collected on 23rd September 1923. (The specimen is rather broken up.)

Differs from *H. brevistylus* Selys, by its rather smaller size, by the face and lips entirely black instead of bright greenish yellow, by the entire absence of humeral and narrow medial lateral stripes (only two stripes in *nigricolor*, two broad and a medial narrow yellow stripe in *brevistylus*), by having 2 cubital nervures instead of only 1, by the longer and less closely-set distal spines on hind femora and by the superior anal appendages slightly longer than the inferior instead of slightly shorter. The appendages differ also in shape (Plate X, figs. 3 and 4).

The occipital plate is only slightly produced backwards in *brevistylus* and has not the striking character seen in *nigricolor*. As Martin does not mention the occiput in his description of *gigas*, it is to be presumed that it has only normal characters as in *brevistylus*.

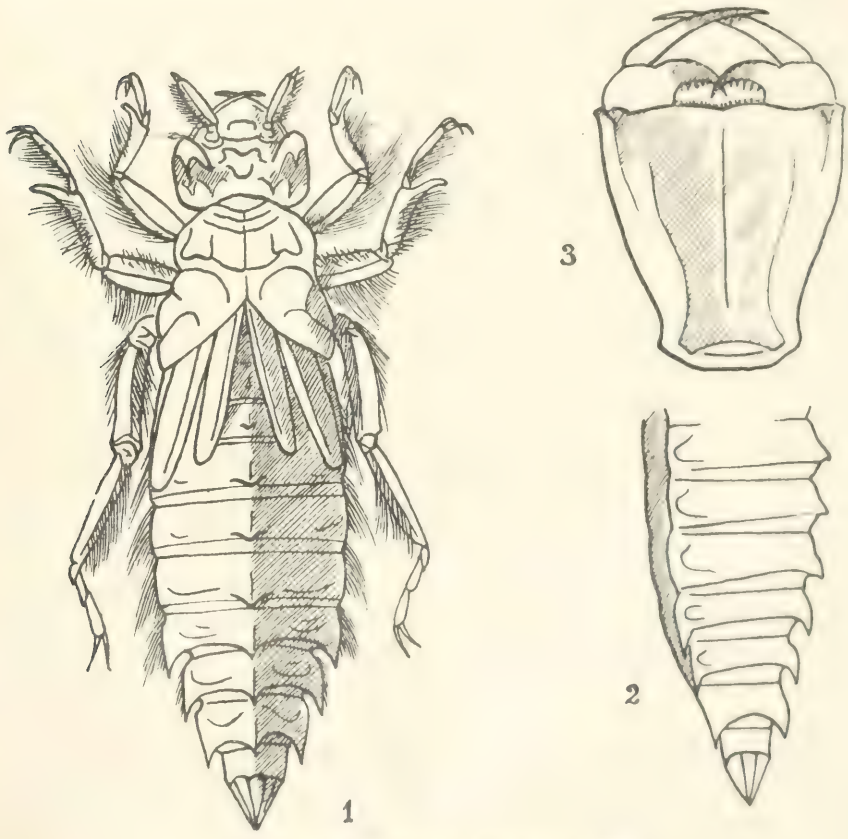
From *H. gigas*, Mart., it differs by its much smaller size (abdomen only 54 mm. instead of 71 mm.), by the antehumeral stripe not confluent with the mesothoracic collar, by a single black stripe on sides of thorax instead of 2 and by the inferior anal appendage nearly as long as the superiors instead

of only one-third as long. The appendages are also quite different in shape.

It is to be remarked that this is the first species of the genus to be reported from within Indian limits and the second from the old World.

Exuvia of *Megalogomphus hannyngtoni*, Fras.

Head broad roughly triangular, eyes slightly produced and projecting forward, antennæ four jointed, the scape and pedicel very short, first distalia



Larva of *Megalogomphus hannyngtoni*, Fras.
1, Larva ; 2, Side-view to show dorsal armature ; 3, Mask.

robust long forming greatest part of antennæ, apical segment very short and minute.

Mask squared but rather longer than broad, lateral lobes massive, apex prolonged into a very robust incurved spine armed with four to five teeth on its inner border, movable hook very long, overlapping, naked.

Synthorax broadening from before back, upper surface broadly mammillated or bossed, wing cases widely divergent extending to apical border of segment 4.

Legs short and robust, femora and tibiæ with a long fringe of coarse hairs on outer surface, tarsi of middle and forelegs similarly so. Anterior two pairs of tibiæ with the distal ends prolonged into robust obtuse spines adapted for excavating.

Abdomen fusiform tumid strongly keeled, tergum arched, venter flattened, mid-dorsal carina of 2nd to 9th segments armed at the apical end, beginning with a small tubercle on segments 2 and 3, gradually lengthening to a robust spine from 4 to 9.

On segment 6 the spine slightly imbricated backwards, strongly so on 7, 8 and 9, these three segments also furnished laterally with backwardly directed spines. Segments 4 to 7 with a lateral fringe of coarse hairs very similar to those on the legs.

Appendix dorsalis and cerci of about equal length, converging to a point.

Total length 46 mm. Breadth at widest part (abdomen, segments 4-5) 13 mm.

This enormous exuvia was discovered in May 1917 by the late Mr. Hannyngton, I.C.S., at Mercara, Coorg. The generic position was determined by a reading of the venation plainly visible on the wing cases. Subsequently the imago was discovered at Hallery, Mercara, by myself and as this is the only species known from Southern India it is to be presumed that the exuvia and imago are conspecific. (Mr. Raymond of Hallery Estate informs me that Mr. Hannyngton, who was then Commissioner of Coorg, spent a good deal of his leisure hours collecting Lepidoptera at Hallery and it may be that the exuvia was discovered by him during one of these visits.)

On the 16th February this year, whilst dredging for larvæ in a small stream two miles beyond Bettageri village, on the Bhagmandala road, Coorg, I was fortunate enough to secure five larvæ corresponding to the exuviæ of *Megalogomphus hannyngtoni*, described above. These were buried fairly deeply in sand at the bottom of a pool at the foot of a rapid. (Such places are always found prolific with Gomphine larvæ.) These were conveyed back to Mercara and placed in shallow dishes with about one or two inches of sand at the bottom.

They remained motionless until near dark when they suddenly began to burrow and quickly disappeared from sight, even the cerci being obscured. During two months they never once showed themselves above the sand although occasionally the dorsal ridge of one or more would be partly visible. Other dragonfly larvæ were given them for food but remained unmolested until I introduced burrowing Gomphine larvæ, and fresh-water shrimps. It was then seen that the larvæ obtain their food by searching for it in the sand, for the surface of the sand was soon strewn with fragments of partially devoured larvæ and shrimps.

The first specimen, a fine female, emerged on the 8th April, crawling out of the water and clinging to the side of its cage just above the water's surface. Emergence took place at 6-30 A.M., but the wings and abdomen were not fully grown until 10 A.M. The insect took quite half an hour to leave its exuviæ and from its low position, it seemed that it had not left sufficient room for its wings to hang and dry. However, both wings and abdomen were held horizontally out, parallel to the earth during this process and in spite of their softness, developed and dried perfectly straight. By one o'clock the pattern was fully developed on the body and by 4 P.M. the ground colour was quite black and the yellow markings beautifully contrasted. Markings and colour mature with great rapidity in most Gomphines.

It is to be remarked that, with the exception of the co-type female, this specimen is the only other female of *hannyngtoni* known.

Macrogomphus montanus, Selys.

It is interesting to report the capture of a female of this species, Pusa, Bihar, 26th June 1923. It is slightly teneral which may explain some slight increase in extent of the yellow markings. The labrum is yellow framed narrowly in and traversed narrowly by black. The antehumeral stripes extend as far up as the alar sinus and are squared against it, they are again broader than usual. The humeral (juxta-humeral) stripes are broader and extend nearly to lower front of dorsum.

The curious shape of the occiput of this species and the yellow markings of thorax are depicted on Plate IX, figs. 5 and 7.

Lamellogomphus cacharicus, sp. nov.

A single female from Dilkhoosh, Cachar, coll., July 1921.

Female. Abdomen 42 mm. Hindwing 38 mm.

Head. Labium dirty yellow, labrum black marked with a small comma-shaped spot at each outer end, bases of mandibles yellow, ante- and post-

clypeus glossy black, the latter marked with a small yellow spot on each side against the eyes, frons black marked with a broad yellow stripe along the crest, vertex and anterior part of occiput black, the posterior part of latter dark brown, simple, straight, no armature, fringed with black hairs.

Prothorax black marked with yellow as follows :—a small spot on each side, the posterior lobe narrowly, two small points on mid-dorsum and a narrow anterior collar.

Thorax black marked with yellow as follows :—a narrowly interrupted mesothoracic collar, antehumeral stripes confluent with the latter and forming inverted figure "7"s, humeral stripe entirely absent. Laterally a broad posthumeral stripe of yellow and the whole of the metepimeron the same colour. These two yellow areas divided by a broken black stripe.

Legs black, coxæ and trochanters yellow, the anterior femora striped with yellow on inner side. Hind femora with a row of short robust moderately closely-set spines.

Wings hyaline, pale rays of saffron in subcostal and cubital spaces extending outward as far as the arc ; pterostigma brown, over 5 to 6 cells, braced robustly ; membrane obsolete ; 1 to 2 rows of cells between *Mi* and *Mia* at distal end of pterostigma ; nodal index $\frac{10\text{-}15 \mid 14\text{-}10}{10\text{-}10 \mid 11\text{-}11}$; 1 cubital nervure in all wings ; 1 to 2 rows of postanal cells in forewing, 4 rows in the hind.

Abdomen black marked with yellow as follows :—a narrow mid-dorsal stripe tapering from segment 1 to the transverse suture on segment 3, the sides of all these three segments broadly yellow, but narrowing progressively from 1 to 3 and not quite extending to apical border of latter. The dorsal and lateral stripes separated by a broad black stripe on either side, segments 4 to 7 with broad basal rings incomplete below and covering nearly one-fourth of segments, 8 with a small baso-dorsal spot, 9 and 10 yellow laterally.

Anal appendages dark brown, minute, pointed.

Vulvar scale short, rounded, not projecting. (This organ crushed and not very easily made out.)

The specimen is slightly teneral and the black colouring, especially of abdomen, not completely matured.

This female is distinguished from *acinaces* and *nilgiriensis* by the mesothoracic collar and antehumeral stripes being confluent. The same character and the absence of a spine on the occiput will distinguish it from *malabarensis*. From Laidlaw's *Onychogomphus* sp. from the Garo Hills, the absence of dorsal spots on segments 3 to 5 and the fusion of the antehumeral bands with the

mesothoracic collar serve to distinguish it. From *inglisi* and *biforceps*, the last character and the entire absence of humeral stripes separate it. From *drummondi*, which it resembles somewhat, the following points of difference are to be noted,—segments 9 and 10 are yellow laterally instead of dorsally, the humeral upper spot seen in *drummondi* is absent, the occiput is black instead of yellow, and lastly the lateral medial black stripe in *drummondi* is very broad and unbroken.

Subfamily Aeshninæ.

Gynacantha apicalis, sp. nov.

Female. (Male unknown.) Abdomen 45 mm. Hindwing 40 mm.

Face and lips pale yellowish brown, anterior border of frons and the sulcus above diffusely brown, the area on either side bluish white, occiput yellow finely bordered on either side behind with black.

Prothorax and thorax pale uniform brown, possibly green during life.

Legs brown, femora bluish white on outer side.

Wings hyaline, apices broadly tipped with brown from about middle of pterostigma, latter yellow braced, nodal index, $\frac{13-14 \mid 16-12}{14-11 \mid 11-14}$, 4 cells in all trigones.

Abdomen blackish brown above, bluish laterally especially from segments 1 to 4, segment 2 has a pair of transverse blue stripes at its middle widely separated by the mid-dorsal carina and a pair of apical blue spots.

These stripes and spots repeated on segments 3 to 7 with an additional narrow blue basal ring formed by an upper extension of the lateral blue, segment 8 with a large triangular blackish brown spot laterally, 9 with a much smaller spot, 10 dirty white.

Described from a single specimen in the Pusa collection, from Lyallpur, collected by G. R. Dutt, October 1921. Distinguished from other species of the genus by the apical marking of wings and also by the extensive blue markings of abdomen.

Aeshna mixta, Latr.

From Srinagar, Kashmir, Mr. Bainbrigge Fletcher sends a new race of this insect which differs from type by having the lateral thoracic bands of thorax bright azure blue instead of greenish yellow. Latreille's original description says,—" deux bandes de chaque côté d'un jaune verdatre " and specimens from Europe which I have compared with the Srinagar series conform to Latreille's description in having the lateral bands yellowish instead of blue as in the Kashmir specimens.

Specimens collected by Mr. Fletcher higher up at Gulmarg and Yusimarg conform to type and he does not think that they could all have been teneral examples of the blue type.

A migratory insect, it is interesting to report that a flight was witnessed by Mr. F. Mitchell above the Sind Valley at an elevation of 13,000 feet, all flying steadily in one direction along the front of the hill-side. That this species must be very hardy is proved by the fact of its being seen at such altitudes and Mr. Fletcher mentions that he picked up a dead specimen lying beside a patch of snow at an altitude of 10,500 feet (above Killanmarg). At Yusimarg the insect was abundant during August, but difficult to take on account of the height at which they flew (20-50 feet). From August to October the insect was noticed flying quite late in the evening, from 6 P.M. until sundown or dark. During the evening they fed on small Chironomids on which they simply stuffed themselves.

Subfamily Cœnagrioninæ.

Cœnagrion violacea, sp. nov.

A single male from Ranchi, collected by T. Bainbrigge Fletcher, 1st September 1922. Abdomen 23 mm. Hindwing 17 mm.

Head. Eyes dark olive green, brownish above ; labium and labrum ochreous ; epistome violaceous traversed by a thick transverse black band, rest of head blackish brown.

Prothorax black, unmarked.

Thorax broadly black on dorsum with a coppery reflection, no humeral stripe, laterally a beautiful violety blue marked by a fine black stripe just anterior to the 2nd lateral suture and a small spot of black on the upper part of suture. The black stripe incomplete below. Legs greenish blue, femora broadly black on extensor surface, tibiæ narrowly black on flexor surface.

Wings hyaline, stigma pale brown between black nervures, its outer side slightly more oblique than inner, braced. Hindwing with 6 postnodal nervures, forewing with 7 to 8. Petiolation very short, *ab* meets *ac* a long way from the posterior margin of wing, *ac* nearer the basal antenodal, arc at the level of distal antenodal.

Abdomen violety blue above, creamy below, marked with black as follows : —segment 1 with a broad dorsal black spot extending from base to apex, 2 with the whole of dorsum bronzed black, 3 to 7 with dorsal black stripes connected to apical black rings, before which they are a little dilated, on segment 7 the band gradually broadening from base to apex and broadly

fused with the apical ring. The last three segments unmarked except 10 which has a small dorsal black cross-like marking. Spines on apical borders of 8 and 9 black.

Superior anal appendages black, shorter than segment 10, divaricate, tapering to a point, a downwardly directed spine at the base. Inferior appendages pure white, very short and barely visible.

Differs from *Cœnagrion dyeri* by its violet colouration and also by the absence of a humeral band.

Subfamily Lestinæ.

Indolestes veronica, sp. nov.

Female. (Male unknown.) Abdomen 35-36 mm. Hindwing 28 mm.

Head. Labium, labrum and cheeks brown, rest of head black.

Prothorax black marked with a narrow mid-dorsal stripe of brown, posterior lobe simple rounded.

Thorax pale brown, dorsum broadly black, the mid-dorsal carina finely and a moderately broad humeral stripe warm brown.

Wings hyaline, palely enfumed, pterostigma four times as long as broad, dark brown framed with paler whitish brown, 10 to 12 postnodal nervures in forewing, 10 to 13 in hind.

Legs yellowish, flexor surfaces broadly black, tibial spines short.

Abdomen pale brown marked with blackish brown dorsally as follows,—Segments 1 and 2 with two parallel stripes separated rather widely by the yellowish brown mid-dorsal carina, segments 3 to 6 similar but the dorsal carina very finely yellow. On all segments the stripes taper basalward but converge and meet finally over dorsum apicalward. Segments 2 to 6 with moderately broad basal yellow annules, 7 to 9 entirely black, 10 dark brown as also are the anal appendages.

Two females from Kumaon, Muktesar, 7,500 feet, collected by Mr. Bainbrigge Fletcher, 1st October 1922. Type in Pusa collection. Differs from other species of the genus by the great length of pterostigma and by the dorsal stripes on segment 2 separated for their entire length or coalescent only a point apicalward. Apparently closely related to *I. helena*.

Lestes nigriceps, sp. nov.

Male. Abdomen 32 mm. Hindwing 21 mm.

Head. Labium, labrum and cheeks pale brown, rest of head matt black. Back of eyes and occiput pruinosed white.

Prothorax black, the anterior lobe, sides and mid-dorsal area pruinosed white.

Thorax black marked with a reddish brown humeral stripe, the sides low down and a stripe between the two lateral sutures yellowish green. The dorsum internal to the humeral lines obscurely marked with two dark green metallic stripes whose outer border is quite straight.

Legs yellow, femora and tibiæ striped narrowly with black, tibial spines moderately long.

Wings hyaline, pterostigma pale brown, four times as long as broad ; 11-12 postnodal nervures to forewing, 9-10 in the hind ; quadrilaterals equal, *ac* midway between antenodals.

Abdomen yellowish brown broadly marked with black or metallic green as follows—segments 2 to 6 and the basal half of 7 metallic green, the remainder matt black, segment 2 with the green stripe split mid-dorsally by a fine black line for its basal three-fourths and widely thereafter.

All stripes expanding apically and joining a fine apical black ring.

Anal appendages (Plate IX, fig. 6) yellowish brown, superior black at extreme apex and base. A short robust spine at inner side of base of superiors after which there is a broad expansion occupying middle third of appendix which then contracts again. Apical third sharply angulated in and down, minutely spined on its outer border. Inferior appendages small, ungulate, about half the length of superiors.

Female. Abdomen 30-32 mm. Hindwing 21-22 mm.

Rather similar to the male, differs as follows,—black on head more restricted and with metallic reflex, back of head reddish brown, not pruinosed. Prothorax pale brown with two fine brown lines on mid-dorsum.

Thorax pale brown with two fine straight metallic green stripes on dorsum. No black markings. Segments 1, the sides and apex of 9 and the whole of segment 10 pale brown. Anal appendages brown conical pointed.

Described from a single male and two females from Pusa, collected by Mr. T. Bainbrigge Fletcher, July 1922. Type in Pusa collection.

The species is closely related to *L. viridula* but differs from it by its longer pterostigma and by the extensive black markings on head and thorax. (I have never observed melanism develop in *viridula*.) The anal appendages are closely similar in shape but differ in colour and the inferiors are slightly longer and narrower.

LIBELLAGINÆ.

Philoganga montana, Selys.

A male of this very rare and archaic insect, which has offered so much difficulty to systematists, was taken by Mr. Bainbrigge Fletcher at Shillong on 5th June 1920. It is of interest to note that the insect was taken at rest with its wings wide open in the horizontal plane. No other specimen was seen although a prolonged search for more was made. *

The anal appendages and antenna of this insect are depicted (Plate IX, figs. 2, 3 and 4).

* A good series, including both sexes, was taken in May and June 1924 at Shillong, where this insect was found in small numbers in two very restricted localities.—T. B. F.

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MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

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BY

DR. WALTHER HORN, BERLIN-DAHLEM

AGRICULTURAL RESEARCH INSTITUTE, PUSA

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ON NEW AND OLD ORIENTAL CICINDELIDÆ.

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Cicindela rhytidopteroides, nov. spec.

IN sectionem VII, 1 collocanda (W. Horn in "Wytsman": Genera, p. 285); differt habitu *Prothymam* (*Rhytidophænam*) *limbatam* sub sp. *inornatam* m. imitante :—Labro brevi nigro-metallico in disco late flavo (♂ ♀); capite, pronoto, prosterno, meso-episternis, abdominis disco nudis. Partibus orbitalibus grossim sparsimque striatis; prothoracis lateribus sat rotundatis, pronoto modice plano dense subtiliterque sculpto; elytris modice convexis ante medium, dense grossimque punctatis punctis insculptis posticem versus gradatim minoribus levioribusque. Pro-episternis ad coxas, meso-epimeris et meta-episternis et laterali metasterni parte dense setosis; femoribus sine pilis curvatis.

Long. 7-7·5 mm. (sine labro).

1 ♀ ♂ : Bengal.

Differt a *Prothyma limbata inornata* statura tota minore gracilioreque; labro, præcipue ♂, paullo breviore (♀ quoque flavomaculato); oculis magis prominentibus, vertice angustiore; pronoto paullo minus convexo, lateribus magis rotundatis; elytris æqualiter sed totis subtilius punctatis, angulo suturali magis rectangulari: 4 primis antennarum articulis pedibusque cœruleo-viridibus; elytrorum margine laterali angusto cyaneo; corpore subtus cyaneo.

The resemblance to *Prothyma limbata* is, at the first view, surprising. The two specimens I possess are in rather bad condition and do not bear a "fixed" hair at the 4 anterior trochanters but as they show at their top

" foveiform " impression, the existence of " fixed " hairs seems me to be certain.

Cicindela pseudo-nana, nov. spec.

Species novam sectionem in tribu VII orientali (W. Horn in " Wytsman ": Genera, p. 285) constituens, inter sectionem 15 et 16 collocanda : differt a reliquis huius tribus septimæ sectionibus labro brevi metallico submarginaliter piloso ; palpis tenuibus, sed non extraordinariter prolongatis ; pronoto supra non convexo, solummodo ad angulos anticos setosulo, subtilissime sculpto (nec " median-eingeschachtelt," nec " quernadelrissig "—sculpto) ; abdominis disco punctato-piloso ; femoribus maxima ex parte non-metallicis, sine pilis unciformibus.

Cicindelæ nanæ, Schaum, similis, differt statura paullo majore, longiore pro-episternis solummodo ad marginem anticum setosis ; abdominis basi-lateraliter nudo. Coloratione magis cœrulescente quam viridescente (sordide) ; elytris ad extremum marginem lateralem tenuiter purpureo-cyaneis splendentibus. Signatura simili, sed puncto infra-humerali paullo majore, ante-apicali paullo minore, stria transversa media ante medium abbreviata. Long 6-6·5 mm. (sine labro).

1 ♂, 2 ♀ (alterum in coll. Moser) : Luzon (Mt. Banahao (IV-VI 1914 : Coll. *Bœttcher*). A Dom. Maindron-Kerremans et a Dom. Moser mihi liberalissime data.

It differs sufficiently from *Cic. nana*, Schaum, by the pubescence of the pronotum, of the pro-episterna and the base of the abdomen. The elytra show inside of the narrow bright violet-reddish stripe a light blue border that runs, by and by, into the greyish greenish dirty colouration of the disk.

Cicindela pseudo-interposita, nov. spec.

Cic. virginea interposita m. simillima, differt elytrorum superficie nigro-violaceo-purpurascente, spina suturali ♂ ♀ longiore ; pronoto breviore, perparum minus glabro, ad angulos anticos satis quibusdam ornatis ; pro-episternis paullo minus sparsim, meta-episternis totis, abdominis 2 primis sternitis lateraliter anguste setosis ; ♂ penis apice extremo leviter curvato. Antennarum articulo 3 ♀ et 4 ♀ distaliter et mandibularum superficie in medio viriditer indutis. Long 9 mm. (sine labro).

♂ ♂ ♀ ♀ ; Insula Panaon (December 1915 : coll. *Bœttcher*).

The place, where generally in the ♀ the " mirror " is situated (anterior disk), is only indicated by just a little lighter colouration. Sometimes the upperside of head and the pronotum bluish-green.

Prothyma hopkinsi confluente-angustata, nov. subspec.

Differt a forma prioritatis labro paullo longiore. ♂ ♀ pronoto angustiore, minus profunde sulcato, minus convexo, magis cylindrico, densius et magis irregularius ruguloso ; elytris angustioribus, densius sculptis, præcipue pone medium magis rugulosis (fere ut in subsp. *rotundato-cuprascens* m.), margine toto læte cœruleo, signatura aut tota ad marginem anguste irregulariterque confluente (solummodo vix ante apicem evanescente) aut macula marginali media ad marginem evidenter dilatata (in utroque specimine hac macula media brevissime intus hamata). Coloratione simili, superficie tota magis opaco-cuprea ; episternis totis cyaneis.—Long 11-13 mm. (sine labro).

1 ♀ ♂ ; Insula Negros (Cuernos Mts., Philippines : coll. *Baker*).

As *Prothyma hopkinsi* m. is so extraordinarily variable, I believe that the new form is but a subspecies of it. It is remarkable by its narrow shape, the " cylindrical " prothorax, the dense punctation of the elytra becoming confluent in form of wrinkles at their posterior half. The yellow marginal markings of the elytra show a tendency of getting connected.

Therates batesi testaceipennis, nov. subspec.

Differt a forma prioritatis elytris testaceis. Long 7 mm. (sine labro).

1 ♀ ; Sandakan (Borneo : coll. *Baker*).

Differs from the species as described by J. Thomson by the testaceous colouration of the elytra : the discoidal convexity of them is lighter yellow.

Therates dormeri m. [wrongly described from " Borneo " : I know now that it comes from Assam (Patkai Hills) and N. Manipur (*Doherty*)] is but a race of *Therates hennigi* m. from the Khasia and Garo-Hills (3,500 ft. : VII. " above Tura "), showing the yellow colouration of the elytra and of the border of the abdomen less developed. In the " priority " form (*hennigi*) all yellow patches of the elytra are confluent near the suture and the anterior blackish discoidal spot is completely missing.

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